

Risk Management Applied to Organizational Strategy – A Case Study Applied to a Continuous Billet Forming Machine

Cleginaldo Pereira de Carvalho, Rosane Leite Antunes

Department of Industrial Engineering, University of the State of São Paulo, Faculty of Engineering of Guaratinguetá, Avenida Dr. Ariberto Pereira da Cunha 333, Pedregulho, Guaratinguetá, São Paulo, Brazil, Zip Code:12.516-410, São Paulo, Brazil

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Keywords — *Continuous casting, hazop, operational risks, risk analysis, risk management.*

Abstract — *Risk management involves a set of structured methods in order to face adverse risks in a planned and systemic way. In general, risk management adds value to the processes and their practices are being consolidated by organizations, no longer an issue only addressed by insurance companies and financial institutions. Nowadays, with the growing evolution of the different aspects that make up an organization, the systemic approach of these factors is considered as the path to reduce and mitigate risks to acceptable levels, raising the equipment safety to admissible parameters. This monograph presents a study of operational risk management through a method called What if, which can be applied as a guiding guide in the identification, analysis and management of risks. Bringing as a result a clear and objective communication about the necessary actions to make them risks acceptable to the organization.*

I. INTRODUCTION

With the growing search for technology and product innovation to be increasingly competitive in the market, so that it acts effectively always aiming at reducing costs and making the business viable, it is clear that the equipment that operates in this journey needs care so that it does not damage and generate costs, which may reflect in the unviability of the business.

Thus, this monograph presents a study of operational risk management applied in a steel mill that manufactures special steels for the automotive industry and, by means of internal technical studies, it was determined that the continuous casting equipment of the melt shop presents a higher operational risk, more precisely in the spinning tower, requiring a more elaborate study on the risk management of the equipment.

According to [1], when risks arise from the uncertainty of the operation itself, they are classified as operational

risks, these when caused by external factors that have a significant impact, such as natural disasters, financial system bankruptcies and terrorist attacks, become very important and serious.

According to [2], risks are divided into endogenous risks that originate from the company itself and exogenous risks that are from the supply chain.

[3], stated six types of risks related to software development: organizational adaptability, skill mix, management structure and strategy, software system design, user participation and training, and technical planning and integration.

According to [4], other groups, which are also called risks are team, organizational environment, system requirements, planning and control, users, and complexity. It is also common to classify the risks according to their priority making it possible to act effectively.

One of the strategies, according to [1], is to use a probability and impact matrix to classify risks in high, medium, and low importance.

1.1 Research Contextualization

The current market requires companies to use other management tools to base their strategic planning, such as Balance Score Card - BSC, among others. This work proposes to make decisions based on the organization's risks. It can deal with operational risks, as well as create a governance that allows the evaluation of market risks, sales, logistics, etc. To this end, tools and methods that classify these risks in the organization will be suggested, to be used as information to build the strategic planning.

In this scenario, Operational Risk Management (ORM) has an important role that places it as a determining factor for companies. The implementation of this system will bring to the knowledge of top management the risks that can cause greater loss, according to studies and research that can evaluate, making it possible to eliminate or mitigate them.

1.2 Research Question

How can one map the risks of a continuous casting machine? Can the risk analysis approach be applied to a continuous caster? In today's scenario, are managers aware of these risks which are usually only found at the operational level?

II. THEORETICAL BACKGROUND

2.1 Risk

According to the Normas Brasileiras/ISO International Organization for Standardization - NBR / ISO 31000 standard [5], risk is defined as the impact of uncertainty on the objectives that an organization faces due to the influence of internal and external factors. Although risk is usually related to circumstances that cause harm to people or assets, this definition means that risk can also appear in the planning process.

According to [3], the goal of using risk management in the process is to reduce uncertainty, define measures to prevent occurrence, and determine the measures that should be taken when risks cannot be avoided, i.e., mitigate, reduce the impact, and reduce the consequences of risk.

It can be said that risk is the impact of uncertainty on objectives. According to [2], this effect is a deviation from expectations - positive and/or negative, objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels

(such as strategic, organization-wide, project, product, and process).

According to [4], uncertainty refers to the state of lack of information about the event, its understanding, its knowledge, its outcome or probability, even if it is a partial state.

Risk is the deviation from a specified reference value and its associated uncertainty. These impacts may be related to safety, health, sustainability, personnel, organization, operations, market, or finance.

According to [4], as the name implies, risk refers to unpleasant or undesirable things that can happen being dangerous or uncertain events. Its occurrence does not depend on the will of the parties involved.

According to [6], risk is always related to what may happen in the future. We can use risk analysis tools to analyze and manage risks in a rational way. The goal is to provide a reference for decision making in order to achieve future well-being. And according to the [7], a risk is an uncertain event or condition that, if it occurs, will have an impact on at least one project goal, which are: scope, schedule, cost, and quality.

According to [4], risk comes from uncertainty that have been identified and analyzed and mitigated, making it possible to plan a response to the supposed event. There are risks that cannot be actively managed, to do this, the project team must develop a contingency plan or consider lessons learned from previous projects. NBR/ISO 31000 [5], defines how organizations of all types and sizes face internal and external influences and factors that make them uncertain if and when they will achieve their objectives. The impact of this uncertainty on organizational objectives is called risk.

2.1.1 Risk Management

According to [8], the main objectives for the company's survival and competition in the market are: to reduce costs, product quality, increase production, protect the environment, extend the life of equipment, and work safety.

According to [4], the goal of maintenance is to keep the equipment in the operating condition specified by the design. The proactive approach has become part of everyday maintenance.

In this way, the strategic nature of maintenance is clearly seen. For [9], competitive strategy means adopting a number of different activities to provide customers with unique value. A company can only outperform its competitors if it can maintain its differences. The difference comes from both the choice of activity and the way the activity is performed.

2.1.2 Risk Analysis

Risk analysis involves the appreciation of the causes and sources of risk, their consequences and the probability that these consequences may occur, this analysis is always continuous and must be constantly updated and evaluated.

According to [10] qualitative risk analysis is performed using risk-impact or probability-impact probability matrices being a method for assessing risks, ranking risks according to the probability and impact values determined in meetings with experts and brainstorming.

Although there are various methods for risk analysis, the following common elements are considered necessary to qualify the process as risk analysis:

- Risk identification;
- Relation of the risk to its consequence;
- Analysis of risk exposure;
- Risk characterization.

According to [5], risk analysis can provide data for decisions that require choices, and choices involve different types and levels of risk. And according to [7], the goal of risk management is to increase the possibility and impact of positive events and reduce the impact that can generate negative events in the project.

The risk assessment process, according to NBR/ISO 31000 [5], is composed of risk identification, risk analysis, and risk assessment.

Risk identification is the first element. The purpose of this element is to generate a comprehensive list of risks based on events that will alter the predicted situation, in order to determine what may happen in different events.

According to the NBR/ISO 31000 standard [5], these events can create, increase, avoid, reduce, accelerate, or delay the achievement of goals. All possible causes and scenarios should be considered. These events and scenarios should show the possible consequences of each event.

According to [5], risk analysis allows you to understand the risks. The second element is the decision about the risk requirements that need to be addressed and the most appropriate strategies and methods to deal with the risks. In this phase, you will analyze the risks, their consequences and probabilities. This can be done by modeling the outcome of the event, inferring from experimental research, or available data.

Consequence analysis points out the type of impact that may occur from a particular deviation or situation.

The impact may have minor consequences but higher probability, or major consequences but lower probability,

or some intermediate outcomes. It is appropriate to focus on the risks that can produce high impacts, these risks are usually of greater concern to managers.

According to [5], risk assessment aims to assist decision making based on the results of risk analysis. This element takes into consideration the risks of the need for treatment and the priority of treatment implementation.

According to [1], any decision made based on identified risks involves two distinct elements: objective facts and subjective views on the impact of the decision. In some cases, a risk assessment may lead to a decision not to address the risk.

2.1.3 Risk Analysis Tools

2.1.3.1 Cause and Effect Analysis

According to [11], cause and effect diagrams (also known as Ishikawa or fishbone diagrams) are very useful for identifying causes of risks. They can be system or process flow charts, which show how various elements of a system interrelate and the cause and effect mechanism or as influences diagrams which are a graphical representation of a problem, which shows causal influences the 6Ms: machine, measure, labor, method and environment; the ordering of events in time and other relationships between variables and outcomes.

The risk identification process generates information, which according to [11], will be used in the evaluation process and other processes. They include lists of identified risks, which will serve as the basis for prioritized risk lists. Risk triggers are very useful in the action plan process input and other processes.

2.1.3.2 What if

The What if method according to [12], proposes general and qualitative analysis, for having an application of simple execution, makes it possible to avoid omitting risks in projects, procedures and standards and still verify behaviors and personal empowerment in work environments.

[13] translates the term What if as the "analysis of hypothetical variations" and points out that the method can help decision makers to simulate the behavior of a complex piece of equipment before any critical decision using technical and historical data to reduce the risk of any unexpected results.

To begin with, the multidisciplinary team must be formed and provided with the following information:

- a) Process diagrams (P&ID's);
- b) Equipment technical data, project and process parameters;

- c) Construction materials;
- d) Relief and ventilation systems;
- e) Inventories of dangerous substances;
- f) Local legislation applicable and compatible with the current situation;
- g) International Standards applicable and compatible with the current situation;
- h) Previous risk analysis with its recommendations;
- i) Material risks (material list, interaction matrix);
- j) Process Incident Reports (summary);
- k) Maintenance History;
- l) Records of Changes that have occurred;
- m) Maintenance and Operational Procedures.

In periodic meetings, with a pre-established agenda, the multidisciplinary team will meet to start the work. In possession of the listed information, the team leader will make a brief presentation of the segment to be studied, the multidisciplinary team will make a field visit to recognize the study segment. Then they return to the room to start the What if.

Its definition is a qualitative risk analysis that allows, by asking questions, the identification of hazards and risks in the process, allowing us to perform a global analysis of a facility or process. It can be used at all points in the facility's life cycle.

The method suggests separating the processes into blocks, to ask the "What if?" questions in a delimited manner. Next, identify the hazards in each block by asking the "What If?" question, looking at all the information in the process, and guided mainly by the following items:

- a) Multi-disciplinary group concerns (Brainstorming);
- b) Process Events;
- c) Equipment Failures;
- d) Relevant changes in the process or its parameters.

And then, it will be necessary to send evidence of the study's conclusion, for this, the Process Safety Analysis documentary should be stored.

This method is often used in first analyses, more comprehensive analyses where you get the most critical scenarios to use other methods. While the 'SWIFT/What if' technique was originally designed for the study of chemical and petrochemical facility hazards, the technique is now widely applied to systems, facility items, procedures, and organizations in general. In particular, it is used to examine the consequences of changes and the risks thus changed or created.

In a second step the questions should be analyzed. If they are answered and do not represent a relevant hazardous condition they are discarded, they are said to be "overcome". If they do represent a relevant hazardous condition, this hazardous condition must be identified and listed in the Production Risks Analyses – PRA spreadsheet; these are the "validated" questions. The dangerous condition is referenced by the number and the What if question.

Once all questions have been answered, the resulting hazardous conditions will be listed, and for each hazardous condition, current causes, consequences, and protections must be listed.

Next, the level of risk is assessed for each hazardous condition identified. The analysis should use the criteria of the Risk Rating Matrix (see Fig. 2). Always put in more detail for future leadership decisions, the criteria, with a little more detail in the description, of the whys.

2.1.3.3 HAZOP (Hazard and Operability Studies)

The Hazard and Operability Studies (HAZOP) method is one of the most widely applied methods and was developed by Imperial Chemical Industries (ICI) in the 1960s [14]. This method uses keywords to study deviations from the design intent of equipment and processes and to determine the causes and consequences of the deviations. Its main objective is during process operation. The HAZOP method is mainly used when implementing a new process or modifying an existing process during the design phase. The ideal method for HAZOP is to conduct surveys prior to the detailing and construction phases of the project, so as to avoid having to change the details or installation when the HAZOP results are determined. Well-known. HAZOP development combines the indisputable advantages of personal experience and skills, as well as teamwork.

According to [15], the HAZOP process is a qualitative technique that uses key words to question how the design intent or operating conditions cannot be achieved at each stage of the design, process, procedure, or system. Usually conducted by a multidisciplinary team in a series of meetings.

Guiding words lead the study group's thinking to fix attention on the most significant system risks. These can be customized for a system, but the most usual are: none, plus, minus, as well as, part of, reverse/opposite, except, and compatibility. Next, the concepts that help in the analysis and are vitally important to understand are defined.

Nodes are determined which are a part of the process delimited to be studied, usually a node is defined by the

practicality of the study, since the same substance is carried or used, the same variables are used, or it is simple to establish the edges. The process of node selection should be performed according to the P&ID's. Deviations are considered to be situations where the process parameter extrapolates the reference value. The sequence of the study is shown in Fig. 1.

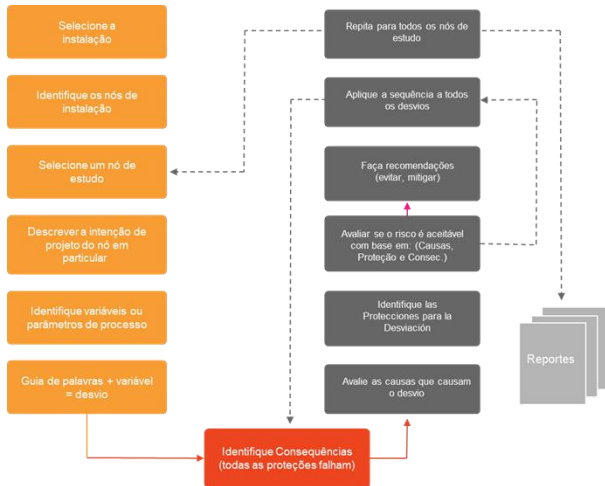


Fig. 1: Hazop sequencing

		Probabilidade de Ocorrência do Risco				
		(1) MUITO BAIXA	(2) BAIXA	(3) MÉDIA	(4) ALTA	(5) MUITO ALTA
Impacto do Risco	(5) CATASTRÓFICO	15	19	22	24	25
	(4) CRÍTICO	10	14	18	21	23
	(3) SÉRIO	6	5	13	17	20
	(2) MODERADO	3	5	8	12	16
	(1) BRANDO	1	2	4	7	11

Fig. 2: 5x5 Risk classification matrix

Source: Authors (2021)

	Grau de Risco	Nível de Risco
	GR1	20 – 25
	GR2	16 – 19
	GR3	7 – 15
	GR4	1 – 6

Fig. 3: Risk level of the probability x impact matrix

Source: Authors (2021)

The consequence (impact) can be estimated taking into account the potential severity that considers: the nature or size of what is at risk: people, financial, environment, quality, image, legal requirement.

Source: Authors (2021)

This method is often used in the detailed design phase and should be used when, after the what if method, no solution has been found for the identified risk. It is a more in-depth method indicated only for the most complex and serious risks.

2.1.3.4 Probability and Impact Matrix

The identified risks go through an Analysis and Evaluation process. In this step the risk is estimated (quantified) and its functional dimension is understood. This risk estimation or quantification is a function of the consequence and probability of an event occurring and is based on the risk matrix in Fig. 2:

The severity, in the case of people referring to damage or injury to health: mild, severe and death, and the extent of the risk: one person, several people and/or equipment.

The probability of occurrence or the materialization of the risk is a function of the frequency of exposure or occurrence: need for exposure, nature of exposure, frequency of exposure, statistical data or history of events can be used. The possibility of avoiding the materialization of the risk should also be considered: if it is slow to occur, if it can be predictable, if it can occur in a sequential manner, if it occurs due to complaints, etc.

It is necessary that the entire risk analysis and assessment process be documented, showing the basis for the correct classification as to consequence and

probability. Examples: calculation report, reports, reports, modification management, evidence of occurrences, etc., in order not to under or overestimate a certain risk. The risk can be analyzed focusing on each of the impact

dimensions, it will have the dimension of the highest risk level evaluated. For this work the financial dimension will be evaluated.

CRITÉRIOS PARA ANÁLISE DE PROBABILIDADE DE MATERIALIZAÇÃO DO RISCO		
NÍVEL	DESCRIÇÃO	DETALHAMENTO
5	MUITO ALTA	Recorrente em operações similares Já ocorreu mais de uma vez. Estatisticamente (por histórico) é esperado que ocorra. A ocorrência é iminente ou é esperada que ocorra em curto prazo. Não existem controles confiáveis
4	ALTA	É provável que ocorra em alguns anos ou com o passar dos anos. Já ocorreu na empresa e não houve ação corretiva efetiva. Uma única causa é suficiente para efetivar o risco, considerando os controles existentes; Controle é fraco e não confiável/não auditado; Há condições agravantes de probabilidade que favorecem a ocorrência.
3	MÉDIA	É provável que ocorra na vida útil do negócio, mas pode ocorrer se houver deterioração ou falta de algum controle. Eventualmente acontece no setor. Equivalente a "ALTA", mas depende de uma 2ª causa para poder ocorrer. Não têm condições agravantes de probabilidade. Até uma redundância de controle.
2	BAIXA	É improvável que ocorra na vida útil do negócio. Já ocorreu no setor mundial, mas é raro. Depende de várias causas para ocorrer, tem várias proteções e redundâncias de modos de falhas diferentes.
1	MUITO BAIXA	Conceitualmente possível, mas extremamente remoto que ocorra na vida útil do negócio. Praticamente impossível de acontecer. Já ocorreu ou não no setor mundial, mas é muito remota essa possibilidade

Fig. 4: Criteria for risk materialization probability analysis

Source: Authors (2021)

In Fig. 4 the criteria relative to the failure frequency are established, with these criteria we classify the risk from very high, which would be the most critical, to very low.

Even those classified as very low are treated due to the impact that this failure may generate.

CRITÉRIOS PARA ANÁLISE DE IMPACTO DO RISCO							
GRAU DE IMPACTO	ESCALA	VETORES DE IMPACTO					
		Segurança e Saúde	Meio Ambiente	Aspectos Legais/Regulatórios	Imagem	Qualidade	Financeira Usina
5	Catastrófico	Acidentes ou doenças que geram lesões que incapacitem permanentemente e/ou causem fatalidade em mais de uma pessoa.	Fora da unidade: Impacto ambiental cujos os efeitos são irreversíveis ou reversíveis entre 5 e 10 anos. Dentro da unidade: Impacto ambiental cujos efeitos são irreversíveis ou reversíveis em mais de 10 anos.	Interdição de colaboradores e/ou perda de licença gerando aumento na rigidez legal e regulatória.	Matérias na imprensa nacional ou internacional negativas com o nome da empresa na manchete. E/ou com grande impacto na credibilidade perante a todos os grupos de stakeholders.	Material fora de especificação enviado a cliente que comprometerá aplicabilidade do produto podendo causar impactos a segurança e/ou saúde.	Impacto financeiro maior que MUS\$ 15 ou 30% do EBITDA mensal da planta.
4	Crítico	Acidentes ou doenças que geram lesões que incapacitem permanentemente e/ou causem fatalidade em uma pessoa.	Fora da unidade: Impacto ambiental cujos os efeitos são reversíveis entre 1 e 5 anos. Dentro da unidade: Impacto ambiental cujos efeitos são reversíveis entre 5 e 10 anos.	Ações de classe e/ou perda de licença sem possibilidade de remanejamento de produção	Matérias na imprensa nacional ou internacional negativas com o nome da empresa. E/ou com impacto mensurável na credibilidade perante os stakeholders.	Material fora de especificação enviado a cliente que comprometerá aplicabilidade do produto podendo causar impactos no desempenho do produto.	Impacto financeiro maior que MUS\$ 10 ou entre 25% e 30% do EBITDA mensal da planta.
3	Sério	Acidentes ou doenças que geram lesões permanentes não incapacitantes.	Fora da unidade: Impacto ambiental cujos os efeitos são reversíveis entre 0 e 1 anos. Dentro da unidade: Impacto ambiental cujos efeitos são reversíveis entre 1 e 5 anos.	Perda temporária de licença (interdição) associada a compromisso formalizado e/ou perda de licença com possibilidade de remanejamento de produção	Matérias na imprensa nacional com a empresa citada em contexto negativo. Presença no ambiente digital de menções negativas relacionadas à marca.	Falha não detectada na Unidade com potencial de comprometer o desempenho do produto ou performance em mais de um cliente	Impacto financeiro entre MUS\$ 1 e MUS\$ 10 ou entre 5 e 25% do EBITDA mensal da planta.
2	Moderado	Acidentes ou doenças que geram lesões não permanentes/incapacitantes com afastamento (CPT).	Dentro da unidade: Impacto ambiental cujos efeitos são reversíveis entre 30 dias a 1 ano.	Autuação em qualquer esfera sem risco de interdição.	Matérias na imprensa local com citação da empresa em contexto negativo.	Falha não detectada na Unidade com potencial de comprometer o desempenho do produto ou performance em um cliente	Impacto financeiro menor que MUS\$ 10 ou entre 2,5% e 5% do EBITDA mensal da planta.
1	Brando	Acidentes ou doenças que geram lesões não permanentes/incapacitantes, sem afastamento (SPT).	Impacto ambiental cujos efeitos são reversíveis com danos de solução menor que 30 dias.	Processos ou sanções apenas em esfera Cível.	Publicidade negativa apenas para o público interno sem comprometimento da confiança no Grupo.	Falha que compromete o desempenho do produto ou performance detectada na Unidade.	Impacto financeiro menor que MUS\$ 1 ou entre 2,5% e 5% do EBITDA mensal da planta.

Fig. 5: Criteria for the evaluation of risk impacts

Source: Authors (2021)

2.1.3.5 FMEA (Failure Modes and Effects Analysis)

FMEA is a technique used to define, identify, and eliminate known failures or deviations in systems, designs, processes, and/or equipment before they reach the customer [16].

Failure Mode and Effect Analysis is a reliability technique with the primary objective of anticipating known or potential failure modes in a product or process (equipment, systems, or components) and identifying actions that can eliminate or reduce the chance of these failures occurring. It is an analytical method based on the

team's experience, which helps in the identification and prioritization of failures.

To assist in the analysis, information such as performance standards, equipment availability, repair cost, loss profile, environmental and safety risk assessment, failure history, reference documentation, and the operational context can be collected.

FMEA can be used to:

- Anticipate product defects or equipment failures, rather than detect and correct after the occurrence, thus having cost and/or operational risk reduction;
- Assist in the selection of design alternatives for assurance of function;
- Identify the modes and effects of human error;
- Provide basis for test planning and maintenance of physical systems;
- Improve design;
- Provide information for analysis techniques such as fault tree analysis;
- Establish benchmarks for similar equipment or systems;
- Improve or standardize the knowledge of the entire team regarding important aspects of quality and reliability of the process or product.

2.2 Continuous Casting Machine

According to [19], since the 1960s, the continuous casting of steel with liquid steel in a single device is the most important technological advancement in metallurgical processes, because it could replace traditional castings performed through ingot moulds, which is very important.

According to [18], the conventional process is considered disadvantageous due to its elevating cost,

because, it requires additional equipment such as furnaces, roughing, rippers, ingot maintenance, intermediate transportation (overhead cranes, etc.) to obtain steel sheets.

According to [19], continuous casting eliminates the cost of the aforementioned equipment, reducing time and cost and improving steel quality. The importance of solidification in the metallurgical process of continuous ingot treatment, such as crystal structure, distribution of non-metallic inclusions, micro and macro segregation, and mechanical properties, is closely related to the steel solidification phenomena.

According to [19], the main function of continuous casting is to continuously transform liquid steel into solid. This is the most effective way to solidify large amounts of metal in a simpler form for subsequent rolling [20]. According to [19], as early as 1856, Henry Bessemer proposed a method of continuous solidification, but it was not until the 1930s and 1940s that continuous casting became a common method of producing nonferrous metals and then became a common method of producing steel in the 1960s. Compared with non-ferrous steel, the lower thermal conductivity of steel and the high temperature of casting lead to some problems in steel foundries.

[19], goes on to inform that in the mid-1980s, continuous casting increased significantly, surpassing the conventional ingot solidification route, and became the main method used in steel production. Currently, a large volume of the world's steel with its most diverse chemical composition and shape, uses continuous casting as its solidification method.

According to [21], the continuous casting process aims to solidify the liquid steel that comes from the secondary refining. The ladle, besides having the function of adjusting the chemical composition of the steel, transports it to the distributor, which in turn has as one of its functions to feed the mold continuously.

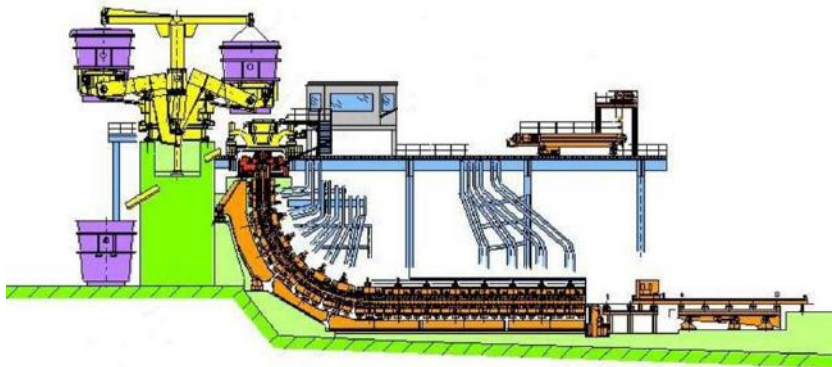


Fig. 6: Continuous casting machine

Source: [22]

The cooling of the steel begins in the copper mold, which in turn is water-cooled. Thus a solidified shell is formed that must have a minimum thickness to withstand the ferrostatic pressure. The mold must oscillate in a way that prevents the steel from sticking to the mold wall. To reduce the friction between the mold wall and the solidified shell, lubricating oil or flux powder is added. The solidified shell is extracted by the extraction machine in conjunction with the rollers and guides that are located after the mold at a rate equal to the casting speed.

At the exit of the mold begins the region of showers (sprays), responsible for the greatest removal of latent heat from the ingot by heat transfer by radiation, conduction in the cooled rollers and evaporation of water from the sprays that bathes the surface of the billet.

Spraying on the surface of the billet can be with air and water or water only. With air and water you get a more uniform application due to the smaller droplet size compared to a water-only spray.

In secondary cooling, the spray zones do not have the same length and, furthermore, the number of zones varies from steel mill to steel mill. It is worth mentioning that one of the internal problems arising from secondary cooling is the midway crack that originates due to too high reheating between the spray zones, as will be seen later.

The last stage of the continuous casting process takes place in the free radiation region. In this phase the ingot is cooled only by natural convection and by heat radiation from the ingot surface to the external environment, while the solidification of all existing liquid up to the oxyfuel area takes place.

III. METHODOLOGICAL PROCEDURES

3.1 Scenario

The company under study is a multinational steel company that operates in the field of special alloyed steels for the mechanical construction industry, mainly for auto parts. It has units in this segment in the states of São Paulo and Rio Grande do Sul. In the unit under study, this

company is composed of three large production areas: Steelmaking, Rolling Mills and Mechanical Transformation. This study will address the risks of the Continuous Casting machine, which is part of the Steel Making process.

As more than 60% of the production of liquid steel produced in the Steel Making Plant goes through the Continuous Casting, we chose to work on the risks involved in this machine.

3.2 Equipment studied

Continuous Casting is the process by which the liquid metal is solidified into a semi-finished product in the form of billet, block or slab. In the case of the machine studied, the billets are square billets of 185 unidade de medida linear milímetros – mm and 155mm. The machine has 6 shafts where the billets are formed and cut to the length required by the customer.

The process is through an oscillating mold, where the mold oscillates up and down with variable speed, allowing a continuous extraction of the shaft with very low friction with the side walls of the mold.

3.3 Method

The application of any risk analysis method should be done considering the strategic planning of the mill and the area.

Resources for risk assessment should be prioritized for the most critical areas. The area leadership should accompany and support the teams involved in the analysis, in order to guarantee that all information, conditions and resources are available in a timely manner, according to the steps described in Fig. 7:



Fig. 7: Operational risk management flow

Source: Authors (2021)

The identification step is a process of search, recognition and detailed identification of risks for this

study, as previously described, the rotating tower was selected, a subset of the continuous casting machine

which for better understanding can be seen below in Fig. 8.

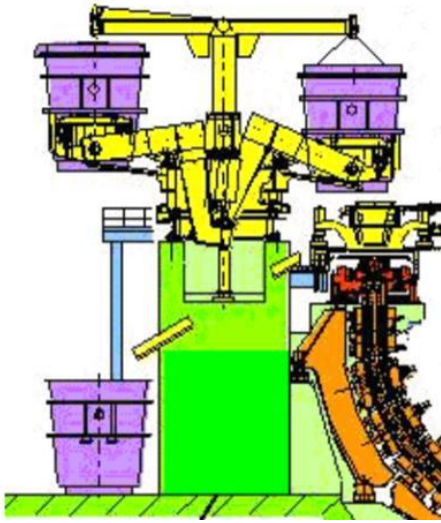


Fig. 8: Representation of a continuous casting tower

Source: [22]

The rotating tower receives the liquid steel pan, released by the electric oven, sustaining it on the distributor. The empty pan is released to the preparation area through a 180° rotation, allowing the quick change of pans and continuing the process.

3.3.1 Evaluation

With the data calculated and the analyses performed, the risks are prioritized through the classification in the 5x5 Matrix in Fig. 2 that relates Impact and Likelihood. First the classification of the Impact is made, considering the value calculated EBITDA – Earn Before Income, Taxation, Depreciation and Amortization of the plant.

After the impact evaluation, the probability of each risk is evaluated based on the parameters in Fig. 4. This evaluation is qualitative and based on the 'know how' of the work team. Hence the importance of the involvement of a multidisciplinary and experienced team. After the classification and prioritization of the risks, they will be studied more deeply and facts and data will be included to support the determination of impact and probability defined in this step.

In possession of this information, the risks are positioned in the 5x5 Matrix in Fig. 2, to obtain the risk grade, and from the classification obtained, the risks are named according to the grade indicated in Fig. 3.

In this way the identified, analyzed, and evaluated risks were prioritized and one can move on to the next step of risk treatment.

The risks classified as Grade - GR1 belong to the Plant Executive Manager, are considered unacceptable, and there should be an action plan with routine checks to verify and bring the risk within acceptable standards.

The risks classified as Grade - GR2 are owned by the maintenance manager of the area where the risk is located and are considered unacceptable, but under control, there must be a monitoring of actions to ensure that this risk does not increase and an action plan to bring it to acceptable standards.

The other risks are owned by the area maintenance coordinator and are considered acceptable, but all their controls and mitigation actions are monitored by the area manager.

3.3.2 Risk Treatment

In this stage the controls will be defined in order to prioritize their implementation. The controls that already exist are also identified, and if they have monitoring of their execution, to ensure that the risk mitigation happens. The respective controls must be defined with the objective of modifying the risks, always seeking to place the risk within the acceptance level.

The implementation of actions to treat risks is not necessarily unique or appropriate for all circumstances. Options for addressing risks may involve one or more of the following approaches:

- Avoid the risk (decision not to initiate the activity that gives rise to the risk);
- Remove the source of risk;
- Change the likelihood;
- Change the consequences;
- Share the risk (e.g. through contracts, purchase of insurance);
- Retain the risk by reasoned decision.

Controls for a given set of risks will generally be broken down into procedures and practices of a technical or managerial nature, and may fall into the following categories:

- Operations Management: operational procedures, best practices related to how to operate processes;
- Maintenance Management: policies and plans related to asset integrity maintenance (e.g. preventive and predictive maintenance plans; inspections and tests; reliability programs; failure analysis, etc.);
- People Management: training of professionals in positions considered critical in relation to risks related to operations;

- Change Management: processes for the management of permanent and temporary changes necessary for the continuity and improvement of operations;

- Emergency Management: set of procedures related to risk scenarios foreseen in the process of Identification, Analysis and Evaluation of Risks;

- Investment Management: risk management process for new installations as well as their impacts on existing processes.

3.3.3 Monitoring

Monitoring has the objective of verification, supervision, critical observation or identification of the situation, performed continuously, in order to identify changes in the level of performance required or expected.

All actions, existing controls are imputed in a system (Power BI or Risk Management Software), so that they are monitored and known to all levels of the organization.

Check meetings are held so that the process is always under control and evolving.

The risks are re-evaluated with frequency according to the Risk Grade. Those classified as GR1 are reassessed annually, GR2 every two years, and the others every five years.

The monitoring of the risk management process uses the following indicators:

- Amount of GR1 risks mitigated;
- % of overdue actions;
- % of Reassessment delayed.

IV. RESULTS

4.1 Risk Identification

The what if step resulted in the following Fig. 9:

ANÁLISE DE RISCOS VALIDADOS E RECOMENDAÇÕES - TORRE GIRATORIA DO LINGOTAMENTO CONTÍNUO					
PERGUNTA ORIGINAL	RISCO	CAUSAS	CONSEQUÊNCIAS	MEDIDAS CONTROLE	RECOMENDAÇÕES
E SE O REDUTOR DO GIRO DO ROLAMENTO QUEBRAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) FALHA DE LUBRIFICAÇÃO B) FALHA DA FIXAÇÃO/ VIBRAÇÃO EXCESSIVA	PARADA 7 DIAS PARA RECUPERAÇÃO E TROCA DO REDUTOR	PLANO DE PREVENTIVA/INSPEÇÃO MECANICA (ELETRICA) E PREDITIVA MENSAL	TER UM REDUTOR RESERVA VERIFICAR VIABILIDADE DE CRIAR REVISÃO BASE TEMPO POR NÃO TER MUITAS FORMAS DE MONITORAMENTO BASE CONDIÇÃO.
E SE O ROLAMENTO DO GIRO FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) FALHA DE LUBRIFICAÇÃO B) FOLGA EXCESSIVA C) FALHA NO PRISIONEIRO DE FIXAÇÃO D) QUEBRA DOS DENTES DO ROLAMENTO	PARADA DE 7 DIAS PARA TROCA DO ROLAMENTO INFERIOR OU SUPERIOR	MEDIÇÃO DE FOLGA DO ROLAMENTO PLANO DE LUBRIFICAÇÃO PLANO DE INSPEÇÃO DO SISTEMA DO GIRO	SISTEMATIZAR PLANO PARA MEDIÇÃO DA FOLGA
E SE A JUNTA ROTATIVA FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) JAZAMENTOS DE OLEO EM MANGUEIRAS E TUBULAÇÕES B) DANO NAS VEDAÇÕES INTERNAS C) TRAVAMENTO DO ROLAMENTO DO GIRO DA JUNTA	PARADA DE ATÉ 2 DIAS PARA TROCA DA JUNTA ROTATIVA	2 JUNTAS RESERVAS MANGUEIRAS RESERVAS PLANO DE MANUTENÇÃO	REVISAR PLANO DE MANUTENÇÃO GARANTIR VEDAÇÃO ESPECIFICADA UTILIZADA NO REPARO.
E SE O PINHÃO DO REDUTOR FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) DESGASTE/QUEBRA DOS DENTES B) FALHA DE LUBRIFICAÇÃO	PARADA DE 7 DIAS PARA USINAGEM DE UM NOVO PINHÃO E INSTALAÇÃO.	PLANO DE PREVENTIVA DO SISTEMA DO GIRO.	MEDIÇÃO DE DESGASTE DE DENTES. INSPEÇÃO POR LIQUIDO PENETRANTE ESTUDAR INSTALAÇÃO DE LUBRIFICANTE SOLIDO NO ENGENHAMENTO PINHÃO X COROA DO ROLAMENTO
E SE O MOTOR PNEUMATICO DO GIRO QUEBRAR.	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) FALHA NO PISTÃO INTERNO B) QUEBRA DO DISCO DE EMBREAGEM C) FALHA DA VALVULA PNEUMATICA	PARADA DE PELO MENOS 8H PARA TROCA DO CONJUNTO.	PLANO PREVENTIVA/INSPEÇÃO MECANICA/ELETRICA MENSAL TEM COMPONENTES RESERVA	NÃO HÁ
E SE O MOTOR ELETRICO DO GIRO QUEBRAR.	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) BAIXA ISOLAÇÃO B) FALTA DE FASE C) TRAVAMENTO DO ROLAMENTO	PARADA DE PELO MENOS 8H PARA SUBSTITUIÇÃO DO MOTOR	PLANO DE MANUTENÇÃO ELETRICA MOTOR RESERVA	MANUTENÇÃO PREDITIVA

Fig. 9: 'Checklist' filling 'What if'

Source: Authors (2021)

To evaluate the impact, the average production capacity of the continuous casting was considered as 76 tons per hour (t/h) and the gross margin as 550 reais per ton (R\$/t). The items that would be necessary to

recompose the function of each equipment were also budgeted with the suppliers. The values for each risk are shown in Fig. 10:

ANÁLISE DE RISCOS VALIDADOS E RECOMENDAÇÕES - TORRE GIRATORIA DO LINGOTAMENTO CONTÍNUO							
ITEM	PERGUNTA ORIGINAL	RISCO	CAUSAS	CONSEQUÊNCIAS	Lucro Cessante	Custo de Recomposição	Custo Total do Impacto
1	E SE O REDUTOR DO GIRO DO ROLAMENTO QUEBRAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) FALHA DE LUBRIFICAÇÃO B) FALHA DA FIXAÇÃO/ VIBRAÇÃO EXCESSIVA	PARADA 7 DIAS PARA RECUPERAÇÃO E TROCA DO REDUTOR	7 (dias) x 24 (h) x 76 (t/h) x 550 (R\$/t) = R\$ 6.987.750,00	Compra do redutor: R\$ 450.000,00	R\$7.437.750,00
2	E SE O ROLAMENTO DO GIRO FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) FALHA DE LUBRIFICAÇÃO B) FOLGA EXCESSIVA C) FALHA NO PRISIONEIRO DE FIXAÇÃO D) QUEBRA DOS DENTES DO ROLAMENTO	PARADA DE 7 DIAS PARA TROCA DO ROLAMENTO INFERIOR OU SUPERIOR	7 (dias) x 24 (h) x 76 (t/h) x 550 (R\$/t) = R\$ 6.987.750,00	Compra do rolamento: R\$1,2 milhões Instalação: R\$400.000,00	R\$8.587.750,00
3	E SE A JUNTA ROTATIVA FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) VAZAMENTOS DE OLEO EM MANGUEIRAS E TUBULAÇÕES B) DANO NAS VEDAÇÕES INTERNAS C) TRAVAMENTO DO ROLAMENTO DO GIRO DA JUNTA	PARADA DE ATÉ 2 DIAS PARA TROCA DA JUNTA ROTATIVA	2 (dias) x 24 (h) x 76 (t/h) x 550 (R\$/t) = R\$ 1.996.500,00	MÃO DE OBRA INTERNA	R\$1.996.500,00
4	E SE O PINHÃO DO REDUTOR FALHAR	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) DESGASTE/QUEBRA DOS DENTES B) FALHA DE LUBRIFICAÇÃO	PARADA DE 7 DIAS PARA USINAGEM DE UM NOVO PINHÃO E INSTALAÇÃO.	7 (dias) x 24 (h) x 76 (t/h) x 550 (R\$/t) = R\$ 6.987.750,00	Usinagem do pinhão: R\$ 230.000,00	R\$7.217.750,00
5	E SE O MOTOR PNEUMÁTICO DO GIRO QUEBRAR.	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) FALHA NO PISTÃO INTERNO B) QUEBRA DO DISCO DE EMBREAGEM C) FALHA DA VALVULA PNEUMÁTICA	PARADA DE PELO MENOS 8H PARA TROCA DO CONJUNTO.	8 (h) x 76 (t/h) x 550 (R\$/t) = R\$ 332.750,00	MÃO DE OBRA INTERNA	R\$332.750,00
6	E SE O MOTOR ELÉTRICO DO GIRO QUEBRAR.	A) FALHA NO GIRO DA TORRE B) PARADA DO LINGOTAMENTO CONTÍNUO	A) BAIXA ISOLAÇÃO B) FALTA DE FASE C) TRAVAMENTO DO ROLAMENTO	PARADA DE PELO MENOS 8H PARA SUBSTITUIÇÃO DO MOTOR	8 (h) x 76 (t/h) x 550 (R\$/t) = R\$ 332.750,00	MÃO DE OBRA INTERNA	R\$332.750,00

Fig. 10: What if checklist with financial impact

Source: Authors (2021)

4.2 Risk classification

For the impact evaluation the EBITDA was considered to be R\$15,500,000.00, thus positioning the risks in the impact table of Fig. 11 was as follows:

IMPACTO	ESCALA	Segurança e Saúde	Meio Ambiente	Aspectos Legais/Regulatórios	Imagem	Qualidade	Financeira Usina
5	Catastrófico	Acidentes ou doenças que geram lesões que incapacitem permanentemente e/ou causem fatalidade em mais de uma pessoa.	Fora da unidade: Impacto ambiental cujos os efeitos são irreversíveis ou reversíveis entre 5 e 10 anos. Dentro da unidade: Impacto ambiental cujos efeitos são irreversíveis ou reversíveis em mais de 10 anos.	Interdição de colaboradores e/ou perda de licença gerando aumento na rigidez legal e regulatória.	Matérias na imprensa nacional ou internacional negativas com o nome da empresa na manchete. E/ou com grande impacto na credibilidade perante a todos os grupos de stakeholders.	Material fora de especificação enviado a cliente que comprometerá aplicabilidade do produto podendo causar impactos a segurança e/ou saúde.	Impacto financeiro maior que MUS\$ 15 ou 30% do EBITDA mensal da planta.
4	Crítico	Acidentes ou doenças que geram lesões que incapacitem permanentemente e/ou causem fatalidade em uma pessoa.	Fora da unidade: Impacto ambiental cujos os efeitos são reversíveis entre 1 e 5 anos. Dentro da unidade: Impacto ambiental cujos efeitos são reversíveis entre 5 e 10 anos.	Ações de classe e/ou perda de licença sem possibilidade de remanejamento de produção	Matérias na imprensa nacional ou internacional negativas com o nome da empresa. E/ou com impacto mensurável na credibilidade perante os stakeholders.	Material fora de especificação enviado a cliente que comprometerá aplicabilidade do produto podendo causar impactos no desempenho do produto.	Impacto financeiro maior que MUS\$ 10 ou entre 25% e 30% do EBITDA mensal da planta.
3	Sério	Acidentes ou doenças que geram lesões permanentes não incapacitantes.	Fora da unidade: Impacto ambiental cujos os efeitos são reversíveis entre 0 e 1 anos. Dentro da unidade: Impacto ambiental cujos efeitos são reversíveis entre 1 e 5 anos.	Perda temporária de licença (interdição) associada a compromisso formalizado e/ou perda de licença com possibilidade de remanejamento de produção	Matérias na imprensa nacional com a empresa citada em contexto negativo. Presença no ambiente digital de menções negativas relacionadas à marca.	Falha não detectada na Unidade com potencial de comprometer o desempenho do produto ou performance em mais de um cliente	Impacto financeiro entre MUS\$ 1 e MUS\$ 10 ou entre 5 e 25% do EBITDA mensal da planta.
2	Moderado	Acidentes ou doenças que geram lesões não permanentes/incapacitantes com afastamento (CPT).	Dentro da unidade: Impacto ambiental cujos efeitos são reversíveis entre 30 dias a 1 ano.	Autuação em qualquer esfera sem risco de interdição.	Matérias na imprensa local com citação da empresa em contexto negativo.	Falha não detectada na Unidade com potencial de comprometer o desempenho do produto ou performance em um cliente	Impacto financeiro menor que MUS\$ 1 ou entre 2,5% e 5% do EBITDA mensal da planta.
1	Brando	Acidentes ou doenças que geram lesões não permanentes/incapacitantes, sem afastamento (SPT).	Impacto ambiental cujos efeitos são reversíveis com danos de solução menor que 30 dias.	Processos ou sanções apenas em esfera Cível.	Publicidade negativa apenas para o público interno sem comprometimento da confiança no Grupo.	Falha que compromete o desempenho do produto ou performance detectada na Unidade.	Impacto financeiro menor que MUS\$ 1 ou entre 2,5% e 5% do EBITDA mensal da planta.

Fig. 11: Criteria for risk impact analysis

Source: Authors (2021)

The second criterion related to the EBITDA percentage was considered, as it would be the most critical case. After the impact evaluation, the probability

of each risk was evaluated, positioning them according to Fig. 12.

CRITÉRIOS PARA ANÁLISE DE PROBABILIDADE DE MATERIALIZAÇÃO DO RISCO		
NÍVEL	DESCRIÇÃO	DETALHAMENTO
5	MUITO ALTA	Recorrente em operações similares Já ocorreu mais de uma vez. Estatisticamente (por histórico) é esperado que ocorra. A ocorrência é iminente ou é esperada que ocorra em curto prazo. Não existem controles confiáveis
4	ALTA	É provável que ocorra em alguns anos ou com o passar dos anos. Já ocorreu na empresa e não houve ação corretiva efetiva. Uma única causa (vide referências) é suficiente para efetivar o risco, considerando os controles existentes; Controle é fraco e não confiável/não auditado; Há condições agravantes de probabilidade que favorecem a ocorrência.
3	MÉDIA	É provável que ocorra na vida útil do negócio, mas pode ocorrer se houver deterioração ou falta de algum controle. Eventualmente acontece no setor. Equivalente a "ALTA", mas depende de uma 2ª causa para poder ocorrer. Não têm condições agravantes de probabilidade. Há uma redundância de controle.
2	BAIXA	É improvável que ocorra na vida útil do negócio. Já ocorreu no setor mundial, mas é raro. Depende de várias causas para ocorrer, tem várias proteções e redundâncias de modos de falhas diferentes.
1	MUITO BAIXA	Conceitualmente possível, mas extremamente remoto que ocorra na vida útil do negócio. Praticamente impossível de acontecer. Já ocorreu ou não no setor mundial, mas é muito remota essa possibilidade

Fig. 12: Criteria for probability analysis

Source: Authors (2021)

We then have the following condition for each assessed risk:

- Risk 1 - Catastrophic impact and high probability;
- Risk 2 - Catastrophic impact and medium probability;
- Risk 3 - Serious impact and medium probability;
- Risk 4 - Catastrophic impact and low probability;

- Risk 5 - Soft impact and low probability;

- Risk 6 - Soft impact and low probability.

With this information, the risks are positioned in the 5x5 Matrix in Fig. 13, to obtain the degree of risk.

		Probabilidade de Ocorrência do Risco				
		(1) MUITO BAIXA	(2) BAIXA	(3) MÉDIA	(4) ALTA	(5) MUITO ALTA
Impacto do Risco	(5) CATASTRÓFICO	15	19	22	24	25
	(4) CRÍTICO	10	14	18	21	23
	(3) SÉRIO	6	9	13	17	20
	(2) MODERADO	3	5	8	12	16
	(1) BRANDO	1	2	4	7	11

Fig. 13: Positioning of risks in the impact x Likelihood matrix

Source: Authors (2021)

From the positioning of the risks in Fig. 13 and the relationship in Fig. 3 we have the following result. The turntable has two Grade 1 risks (GR1), one Grade 2 risk (GR2), one Grade 3 risk (GR3) and two Grade 4 risks (GR4).

4.3 Existing controls and mitigation/elimination actions

For this step, the highest risk was prioritized in order to detail the actions that are implemented for this risk. Thus, Fig. 14 shows the existing controls for the risk "What if the tower's slewing bearing reducer fails".

CONTROLES EXISTENTES							
Item	Descrição da ação ou controle	Status atual da ação	Impacto da ação na mitigação do Risco	Responsável e Datas	Gerenciamento da Ação		
1	Plano de preventiva de lubrificação para verificação do nível de óleo e completar se necessário. Verificar existência de vazamentos e substituir mangueiras e conexões	Ação executada trimestralmente.	Impacto na probabilidade do risco sendo um dos controles para evitar a falha por falta de lubrificação.	Status da Ação: Executada	Prioridade: Alta	É monitorada?	SIM
				Registrada por: Gestor de GRO	% Redução da probabilidade: 5%	Qual frequência?	3M
				Responsável: Padrinho	% Redução do Impacto: 0%	Quem monitora?	Programador
				Prazo: Concluída		Número do Plano	159192
2	Plano de inspeção mecânica para verificação da fixação, folgas ou ruído anormal	Ação executada mensalmente.	Impacto na probabilidade do risco sendo um dos controles para evitar a falha por vibração	Status da Ação: Executada	Prioridade: Alta	É monitorada?	SIM
				Registrada por: Gestor de GRO	% Redução da probabilidade: 5%	Qual frequência?	1M
				Responsável: Padrinho	% Redução do Impacto: 0%	Quem monitora?	Programador
				Prazo: Concluída		Número do Plano	159191
3	Plano de preditiva para análise do óleo	Ação executada trimestralmente.	Impacto na probabilidade do risco sendo um dos controles para evitar a falha por lubrificação.	Status da Ação: Executada	Prioridade: Alta	É monitorada?	SIM
				Registrada por: Gestor de GRO	% Redução da probabilidade: 5%	Qual frequência?	3M
				Responsável: Padrinho	% Redução do Impacto: 0%	Quem monitora?	Programador
				Prazo: Concluída		Número do Plano	270396
						Data última execução:	12/03/2021

Fig. 14: Existing Controls

Source: Authors (2021)

In Fig. 15, it is possible to observe the maintenance policies established to mitigate the risk, but they do not guarantee that the failure will occur again, they are not considered robust controls because they depend on human action for execution.

Therefore, the risk remained classified as high probability.

The recommendations for this risk are also listed, as can be seen in the 'what if' in Fig. 9, actions that still need to be taken, either to mitigate or eliminate the risk.

AÇÕES DE MITIGAÇÃO/ELIMINAÇÃO DO RISCO							
Item	Descrição da ação ou controle	Status atual da ação	Impacto da ação na mitigação do Risco	Responsável e Datas	Gerenciamento da Ação		
1	Aquisição de um redutor reserva.	Redutor especificado e orçado no mercado. Aguardando liberação de recurso	Redução do tempo de parada de 7 dias para 18 horas. Reduzindo o impacto de R\$7mi para R\$750mil	Status da Ação: Em andamento	Prioridade: Alta		
				Registrada por: Gestor de GRO	% Redução da probabilidade: 0%	Custo Implantação:	R\$ 450.000,00
				Responsável: Padrinho	% Redução do Impacto: 89%	Benefício Financeiro (Se houver)	0
				Prazo: 30/12/2021	% de Conclusão: 30%		
2	Criar plano de manutenção para troca programada base tempo.	Não iniciada	Garantir condição de funcionamento do redutor, executando as verificações necessárias conforme o plano de manutenção.	Status da Ação: Não iniciada	Prioridade: Média		
				Registrada por: Gestor de GRO	% Redução da probabilidade: 1	Custo Implantação:	R\$ -
				Responsável: Padrinho	% Redução do Impacto: 0%	Benefício Financeiro (Se houver)	Calcular
				Prazo: 30/06/2022	% de Conclusão: 0%		

Fig. 15: Risk mitigation and/or elimination actions

Source: Authors (2021)

For the case evaluated, performing the action of acquiring a spare part will bring the risk to acceptable parameters. Reassessing the financial impact of this risk

in Fig. 11, the impact would be classified as moderate and the probability would remain high:

		Probabilidade de Ocorrência do Risco				
		(1) MUITO BAIXA	(2) BAIXA	(3) MÉDIA	(4) ALTA	(5) MUITO ALTA
Impacto do Risco	(5) CATASTRÓFICO	15	19	22	24	25
	(4) CRÍTICO	10	14	18	21	23
	(3) SÉRIO	6	9	13	17	20
	(2) MODERADO	3	5	8	12	16
	(1) BRANDO	1	2	4	7	11

Fig. 16: Reassessment of risk

Source: Authors (2021)

The risk would be classified as a GR3 according to Fig. 3 and considered acceptable by the organization, with the controls shown in Fig. 15 being maintained and the scheduled exchanges being performed as shown in Fig. 16.

4. 4 Communication and Documentation

In possession of all the necessary information, the specialist in the area prepares a One Page that contains all the information for decision making by the company's top management, whether it is the purchase of the necessary item, or to assume living with the risk and thus ensure that the controls are executed so that it does not occur during the period.

The One Pages are presented to the managers, involving all interested parties in the dialogue about the general Risk situation and the measures taken by those responsible. Its objective is to know and validate all the stages of the risk management process.

For the risk studied, as an example in this work, we have in Fig. 17 the 'One Page' with the main information, which will also have a detailed study based on facts and data to ensure the credibility of the values and information presented.

Área:	1-ACIARIA	Nome do Risco:	QUEBRA DO REDUTOR DO GIRO DA TORRE	Freq. de Revisão:	ANUAL	GR INICIAL	GR ATUAL	GR ALVO	Núm Falha
Equipamento:	LINGOTAMENTO CONTÍNUO	Owner:	COORDENADOR DA ÁREA	Data da Revisão:	mai/22	GR1	GR1	GR3	XXXXX
Subconjunto:	TORRE GIRATÓRIA	Aprovado por:	GERENTE DA PLANTA	Responsável:	ESPECIALISTA DA ÁREA				
DESCRIÇÃO COMPLETA DO RISCO					CENÁRIO / HISTÓRICO				
QUEBRA DO REDUTOR DO GIRO, PODENDO PARAR O PROCESSO DO LINGOTAMENTO CONTÍNUO POR 7 DIAS RISCO DE DESABASTECIMENTO DA CADEIA AUTOMOTIVA					EQUIPAMENTO DE EXTREMA IMPORTÂNCIA PARA O PROCESSO, SENDO RESPONSÁVEL POR 60% DE TODO AÇO PRODUZIDO NA ACIARIA E QUE ABASTECE OS DOIS LAMINADORES DA EMPRESA. LINHA DE PRODUTO DESTINADA AOS FABRICANTES DE AUTOPEÇAS SENDO CLIENTES MUITO CRÍTICOS PARA O NEGÓCIO. EQUIPAMENTO DE 1975, BASTANTE ROBUSTO, MAS QUE NECESSITA DE CONTROLES DEVIDO A VIDA ELEVADA. NÃO HÁ HISTÓRICO DE FALHAS NO SUBCONJUNTO ESTUDADO E/OU REFORMA RELEVANTE.				
FOTO DO RISCO					CONSEQUÊNCIAS				
					PARADA DO PROCESSO POR 7 DIAS PARA RECUPERAÇÃO E TROCA DO EQUIPAMENTO. GERANDO UM IMPACTO FINANCEIRO DE R\$ 6.987.750,00				
					CONTROLES EXISTENTES				
					ROTINAS DE MANUTENÇÃO PREVENTIVA E PREDITIVAS PARA ATUAR NA REDUÇÃO DA PROBABILIDADE DA FALHA				
PRINCIPAIS AÇÕES DE MITIGAÇÃO/ELIMINAÇÃO DO RISCO					IMPACTO NO RISCO		CUSTO DE IMPLANTAÇÃO		
1	AQUISIÇÃO DE REDUTOR RESERVA				REDUÇÃO DO IMPACTO DE R\$7MI PARA 750mil, REDUZINDO O GRAU DO RISCO PARA GR3		R\$ 450.000,00		
2									
3									
5									

Fig. 17: One Page

Source: Authors (2021)

The 'One Page' shown in Fig. 17 becomes the cover page of this study that will help the specialist in the presentation to answer questions from top management.

All the risks are archived, forming a book used for the preparation of the company's strategic planning, budgets, and investment plans.

V. CONCLUSION

The present work had as a proposal to present a systematic of identification, analysis and evaluation of the risks of a company, in order to inform the top management in a simple and objective way, about the operational risks contained and that are under their responsibility, showing the controls that are within the possibilities of the area to perform and informing the financial needs or proposing solutions to mitigate or eliminate these risks. The exposed objectives were validated and achieved.

For a manager it is complex to know and manage all the operational risks that the organization has. Without their knowledge, there is no possibility of creating or evaluating controls that can prevent the occurrence of disasters or unwanted events. For this reason, this work will serve as a guide for professionals to use in the most diverse equipment.

The work could have covered a larger and diverse amount of equipment, which would have brought a greater confirmation of its applicability.

For future studies, it is suggested to evaluate the other dimensions considered in the impact matrix, thus having a comprehensive portfolio, which will provide subsidies for the control of all the organization's processes. The use of other methods for more complex risks and also the use of machine learning software that can help both in the automation of the classification matrix and in the estimation of probability.

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